

## REPORT ON THE FRESH-WATER BRYOZOA OF THE UNITED STATES.<sup>a</sup>

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The fresh-water Bryozoa do not constitute a natural group of animals, but have descended from ancestors belonging to widely distinct families. There can be no question that these ancestors were marine animals. Excepting the suborder Phylactolemata, all fresh-water Bryozoa belong to groups most of whose representatives are marine. The fresh-water forms seem to have made their way up estuaries and rivers to lakes and ponds. Here they acquired the capacity of forming statoblasts or hibernacula, by virtue of which the species was enabled, on the one hand, to survive the winter and, on the other, to be carried by waterfowl and winds over divides from one drainage basin to another. Thus the fresh-water species have become nearly cosmopolitan. *Plumatella princeps* has been found in North and South America, throughout Europe, in Molucca, Japan, and Australia—i. e., in all but one of the great geographical divisions of the land areas of the globe. The localities given in the following list do not at all represent the true area of distribution of fresh-water Bryozoa in North America, but only the regions where the inhabitants of the waters have been carefully studied. These regions are for the most part eastern Maine (Hyatt); eastern Massachusetts (Hyatt and the writer); southeastern New York, especially Cold Spring Harbor, Long Island (the writer); vicinity of Philadelphia and Baltimore (Leidy, Potts, and Hyatt); lakes Erie and Michigan (Reighard, Ward, Forbes, Landacre, and the writer); Illinois lakes and rivers (Forbes and H. Garman); Yellowstone National Park (Forbes). It is

<sup>a</sup>This paper is based chiefly on materials collected during 1898 and 1899 by the laboratory of the U. S. Fish Commission, located at Put in Bay, Ohio, and under the direction of Prof. Jacob Reighard; by the Illinois State Laboratory of Natural History, Prof. S. A. Forbes, director; and by the writer in the Eastern and Middle States. It was made at the request of Professor Reighard and all recorded data on the distribution of American fresh-water Bryozoa have been consulted in its preparation.

much to be hoped that records will be published concerning the occurrence of the various species in the Central, Southern, and Pacific States. The writer will be glad to receive references to or separate copies of such published records. To facilitate the publication of such records the following synoptic key to the fresh-water Bryozoa is given. This includes a single species (*Victorella parvula*) unrecorded for America, which may be found here in the future. The key and list are based on the classification of Kraepelin (1887).

SYNOPTIC KEY TO SPECIES.

- a. Anus opening inside the tentacular corona; tentacles incapable of complete retraction (Endoprocta) ..... *Urnatella gracilis*.
- aa. Anus opening outside the tentacular corona, which is capable of being retracted (Ectoprocta).
- b. Zooecia sharply separated from each other; no epistome (Gymnolemata).
- c. Stock consists of cylindrical zooecia and long stolons, which latter enlarge at intervals to give rise to new cylindrical zooecia. The zooecia by lateral budding produce stolons or new zooecia directly. Aperture terminal. *Victorella parvula*.
- cc. Stock consists of cylindrical zooecia, stolons, and irregular swellings, which constitute winter buds. The zooecia do not produce lateral buds. Aperture terminal ..... *Pottsiella erecta*.
- ccc. Zooecia club-shaped; no stolons; aperture lateral. . . . *Paludicella ehrenbergii*.
- bb. Zooecia confluent; epistome present (Phylactolemata).
- c'. Statoblasts without hooks, rounded at ends.
- d. Tentacles 20-22, arranged nearly in a circle; statoblasts without peripheral float ..... *Fredericella sultana*.
- dd. Tentacles 40-60, arranged in the form of a horseshoe. Free elliptical statoblasts with a peripheral float (*Plumatella*).
- e. Colony with vertical as well as horizontal branches.
- f. Cuticula thick and brown, with a keel that broadens at aperture. Free statoblasts elongated; proportions 1:1.53 to 1:2.8. *Plumatella princeps*.
- ff. Cuticula rarely browned or keeled. Free statoblasts nearly circular, 1:1 to 1:1.5 ..... *Plumatella polymorpha*.
- ee. Horizontal branches only. Cuticula delicate, colorless, hyaline. Elevated aperture-cone wrinkled and bespreckled with white. Free statoblasts nearly circular ..... *Plumatella punctata*.
- c'c'. Statoblasts without hooks; acutely pointed at both ends. *Lophopus cristallinus*.
- c'c'c'. Statoblasts with hooks.
- d'. Stock compound, composed of many rosettes of individuals. A thick gelatinous base secreted. . . . . *Pectinatella magnifica*.
- d'd'. Stock caterpillar-like, with a broad sole but no gelatinous base. *Cristatella mucedo*.

ECOLOGY OF THE FRESH-WATER BRYOZOA.

The fresh-water Bryozoa live in all kinds of fresh waters and are indeed among the most ubiquitous of aquatic animals. They are found in stagnant pools and in rushing rivers, although particular species favor special habitats. The different species of *Plumatella* occur in varied habitats. *Paludicella* and *Pectinatella* favor running water and *Lophopus*, *Cristatella*, and *Plumatella polymorpha fungosa* favor quiet

ponds. The fresh-water Bryozoa feed on microscopic organisms which are caught in the vortex created by their ciliated tentacles. Diatoms are especially conspicuous objects in their alimentary tracts. Since diatoms require light for their constructive metabolism, they are found chiefly in the upper strata of the water, and consequently Bryozoa are usually not found at great depths. However, in a mass of material dredged by Prof. H. B. Ward<sup>a</sup> from the Middle Ground Traverse Bay, Lake Michigan, at a depth of 23 to 36 meters, I found *Paludicella chrenbergii* and *Fredericella sultana* abundant. Although *Cristatella* is usually found on the under side of floating lily pads or in other situations near the surface, I have obtained it from the still waters of Trinity Lake, Westchester County, New York, at a depth of 2 to 3 meters. Asper<sup>b</sup> records dredging *Fredericella sultana* in certain Swiss lakes at a depth of 50 to 80 meters. Little light penetrates to such a depth, and we may conclude that light is not at all directly necessary for the development of fresh-water Bryozoa. Indeed, I have received from Prof. D. S. Hartline, of Bloomsburg, Pennsylvania, masses of *Paludicella* that were obtained from water pipes where they flourished to an alarming extent. The Bryozoa have become adapted to life in ponds by forming statoblasts at certain seasons of the year. The entire significance of the statoblast is not sufficiently known. Typically, they winter over and one may find the shores strewn with them in the early spring. They hatch out in New England late in May or early in June. So the statoblasts have come to be regarded as winter buds, or adaptations to preserve the race from being killed off by freezing of the water. They often begin to develop early in the summer and I have observed what has been seen by European observers, that some statoblasts hatch in nature even in September.<sup>c</sup> Also Fr. Müller has informed Kraepelin<sup>d</sup> that the fresh-water Bryozoa of Blumenbau, Brazil, which experience no winters, nevertheless form statoblasts. It seems fair to conclude that there are other functions performed by the statoblasts than resistance to winter. For instance, they serve to maintain the species during drought, or they aid in distribution by clinging to the waterfowl or resisting the action of digestive fluids. The wide distribution of the species of fresh-water Bryozoa indicates the value of the statoblast in the act of dispersion.

#### METHODS OF PRESERVING.

The chief difficulties in the way of preserving fresh-water Bryozoa arise, first, from the rapid contraction of the polypides into the corn and, secondly, in the case of the gelatinous forms, from the large

<sup>a</sup> Bulletin Michigan Fish Commission, No. 6, 1896, p. 13.

<sup>b</sup> Zoologischer Anzeiger, III, 1880, p. 200.

<sup>c</sup> Bull. Mus. Comp. Zool., XX, 1890, p. 102.

<sup>d</sup> Kraepelin, Die Deutschen Süßwasser Bryozoen, 1887, p. 86.

amount of water in the body; for, if the specific gravity of the killing or preserving medium is very different from that of water, distortion will occur.

To kill expanded it is necessary first to narcotize. Chloral hydrate is used, added slowly in crystals until the polypides do not react to touch. To preserve in the natural form, the animals may be plunged directly into  $\frac{1}{2}$  per cent formaldehyde (formalin, 10 per cent).

The classification of fresh-water Bryozoa has been in a state of great confusion owing to the great variability in the form of the colony. The form of the colony depends very largely upon external factors, such as food supply, form of substratum, and crowding. The statoblast has a form that is quite independent of external factors, and upon it, consequently, great stress is laid in systematic work. The form of the statoblast is, however, not wholly uncorrelated with that of the stock, so the form of the stock is to be considered. In the following classification that proposed by Kraepelin<sup>a</sup> has been adopted entire, although it does not conform to the writer's judgment in all particulars.

A LIST OF ALL FRESH-WATER BRYOZOA HITHERTO FOUND IN THE UNITED STATES AND THE LOCALITIES WHERE THEY HAVE BEEN OBSERVED.

#### Subclass 1.—ENDOPROCTA.

This subclass comprises chiefly marine species, the only exception being *Urnatella gracilis*, which was first described from the neighborhood of Philadelphia, but which also inhabits the Mississippi Valley.

#### Family PEDICELLINIDÆ.

##### URNATELLA Leidy.

##### URNATELLA GRACILIS Leidy (1851).

Stock consisting of a basal plate, from which there usually arise two segmented stems terminating in the polypide. More rarely one or more than two stems arise from the disc.

*Habitat*.—Running water.

*Distribution*.<sup>b</sup>—Schuylkill River under low-tide mark below Fairmount dam, Philadelphia, 1851–1870, Leidy; \*canal at Fairmount, near Philadelphia, 1884, Potts (Leidy, 1884), 1890, Potts and C. B. D.; Scioto River, Ohio, Lea (Leidy, 1883, p. 6); \* Illinois River at Havana, Illinois, Station E (middle of river), August, 1895 (Kofoid, 1898).

The specimens from the Illinois River contrast with those from Fairmount in the profuseness with which they form lateral buds. (Plate V, fig. 1.)

<sup>a</sup> Die Deutschen Süßwasser Bryozoen, 1887.

<sup>b</sup>An asterisk before a locality name indicates that specimens from the locality have been examined by the author.

## Subclass 2.—ECTOPROCTA.

## Order GYMNOLÆMATA.

## Suborder CTEXOSTOMATA.

Includes chiefly marine species, but also a number of fresh-water genera.

## Family PALUDICELLIDÆ.

## POTTSIELLA Kraepelin (1887).

Colony consists of stolons, from which at intervals an erect, cylindrical, hyaline single individual arises, having a terminal aperture. Lophophore circular, 20 (19 to 21) tentacles.

## POTTSIELLA ERECTA Potts (1884).

*Paludicella erecta* POTTS.

*Pottsiella erecta* KRAEPELIN, 1887.

This species possesses the characters of the genus. (Plate V, fig. 2.)  
*Habitat.* Photophil; on upper surface of stones in rapids; sometimes penetrating incrusting sponges, particularly *Megevia leidyi*.

*Distribution.*—\*Tacony Creek, near Chiltenham, Montgomery County, Pennsylvania, 50 feet above tide water. (Potts and C. B. D., 1892.)

## PALUDICELLA Gervais.

Stock composed of individuals that are sharply separated from one another by partitions; sparsely, usually oppositely, branched; with a chitinous cuticula. The individuals are club-shaped, with a lateral, quadrangular aperture near the larger, distal end. Tentacles arranged in a circle, few in number. No statoblasts, but winter buds instead.

## PALUDICELLA EHRENBERGHII van Beneden (1848).

Aperture-cone short; individuals about 2 mm. long; lateral buds partly repent, partly erect; about 16 tentacles. (Plate V, fig. 3.)

*Habitat.*—Especially flowing streams; occasionally in water pipes.

*Geographical distribution.*—Europe; India; \*Arlington Creek, Arlington, Massachusetts, under railway bridge near Massachusetts avenue (C. B. D., 1890); \*Bloomsburg, Pennsylvania, 1900 (Hartline); \*Illinois River at Havana, Station G (Thompsons Lake), May 9, 1894; \*Middle Ground, Traverse Bay, Lake Michigan (Ward, 1896).

The specimen figured differs from a German specimen figured by Kraepelin by the individuals being relatively smaller at the distal end.

## Order PHYLACTOLÆMATA.

## Family FREDERICELLIDÆ.

Lophophore nearly circular; statoblasts without peripheral float.

## FREDERICELLA Gervais.

Stock branched in form of antlers; more rarely massed with recumbent and elevated tubes; mostly brown or incrustated with algæ and grains of sand; rarely hyaline. Tubes cylindrical, the older ones mostly keeled. Without complete dissepiments. Apertures terminal at the broadened or bifid ends of tubes. Polypide very long and slender; tentacles arranged in a nearly circular corona. Few tentacles, not exceeding 24. Statoblasts dark brown, bean-shaped or elliptical, without float, and with smooth upper surface.

## FREDERICELLA SULTANA Blumenbach (1777).

*Fredericella walcottii* HYATT (1868).

*Fredericella pulcherrima* HYATT (1868).

*Fredericella regina* LEIDY.

This species has the characters of the genus. (Plate V, fig. 4).

*Habitat*.—On wood, stones, and water plants in standing and slowly flowing waters.

*Distribution*.—Europe; Australia; Pennisewassee Pond, Norway, Maine; Youngs Brook, Gorham, Maine (Hyatt, 1868); Lake Sebago, Maine (Hyatt); Fresh Pond, Cambridge, Massachusetts (Hyatt); Georgetown, Massachusetts (Hyatt);\* Lily Pond, Newport (Leidy); Schuylkill River and Delaware River near Philadelphia (Leidy); Gwinns Falls, Baltimore, Maryland (Hyatt); \*Middle Ground, Traverse Bay, Lake Michigan, 23 to 36 meters (Ward, 1896); \*Hatchery Harbor, Put-in Bay, 1899; \*East Harbor, Sandusky, Ohio, 1899; \*Erie, Pennsylvania, Boat Landing; \*Illinois River at Havana, Illinois, Station G (Thompsons Lake) 1894; \*Lake Geneva, Wisconsin, off Long Point, July, 1891 (Forbes); \*Lake Geneva, dredging from Forest Glen to Belvidere, May, 1892 (Forbes); \*Flathead Lake, Yellowstone National Park, August, 1891 (Forbes).

## PLUMATELLA Lamarek (Kraepelin).

Colonies consist of cylindrical tubes, which are either branched or form massive clumps or run over the substratum as hyaline, lobed tubes. Partitions rudimentary or absent, cuticula brown to hyaline, often incrustated. Tentacular corona markedly horseshoe shaped, with 40 to 60 tentacles. Intertentacular membrane present. Statoblasts

without hooks; either free, elliptical, with broad float, or (in the horizontal tubes) without float, of large size and irregular shape.

The commonest genus of our fresh-water Bryozoa. Has been reported from all continents except Africa. Lives in the most diverse habitats, in ponds or streams, usually not in the light.

#### PLUMATELLA PRINCEPS Kraepelin.

*Plumatella emarginata* ALLMAN, 1844.

*Plumatella repens* VAN BENEDEEN, 1848.

*Plumatella diffusa* LEIDY, 1851.

Branches both vertical and horizontal. Cuticula thick and brown with a keel that broadens at the aperture.

Var.  $\alpha$ , *emarginata*.—Tubes openly branched, repent, with short lateral branches, antler-like. (Plate V, fig. 5.)

\*Squaw Bay, Put-in Bay, July 17 and 18, 1899, on lily stems and leaves; \*Rondeau Harbor, Ontario, August 30, 1899; \*Flathead River, Montana Bayou, on bark and rotten logs, August 19, 1891 (Forbes); \*Big Creek, Hamilton County, Illinois, October 3, 1900.

Var.  $\beta$ , *fruticosa*.—Colony robust, branched, often rising from substratum. Keel little developed. Statoblasts elongated.

\*Erie, Pennsylvania, Boat Landing, August 16, 1899.

Var.  $\gamma$ , *mucosa*.—Vertical branches predominate, forming an intertwined mass.

Var.  $\delta$ , *spongiosa* (= *Alicyonella Benedeni* Allman).—Vertical tubes fused into a mass from which only the apertures rise free.

Havana, Illinois, Station G (Thompson's Lake), April 10, 1895; Matanzas Lake, Illinois River, July 9, 1896.

#### PLUMATELLA POLYMORPHA Kraepelin.

With vertical as well as horizontal tips of branches. Cuticula rarely browned or keeled. Includes numerous synonyms, especially *Plumatella corallioides* Allman; *P. elegans* Allman; *P. dumortieri* Allman; *P. nitida* Leidy (1851); *P. arethusa* Hyatt (1868). Found on all continents except Africa.

Var.  $\alpha$ , *repens* (= *P. arethusa* Hyatt).—Tubes creeping with short vertical side branches. Cuticula mostly semitransparent; keel not evident. (Plate V, fig. 6.)

\*Squaw Bay, Put-in Bay, July 12, 1899; \*Long Point, Canada, August 23, 24, 1899; \*Rondeau Harbor, Ontario, "East Swamp" and Business Creek, August 28, 29, 1899; \*Swan Lake, Montana, under stones, August 24, 1891; \*Havana, Illinois, Station L (Dogfish Lake), August 7 and 23, 1895.

This form varies greatly in the thickness and transparency of the cuticula. The specimens from Long Point have an unusually thick and clear cuticula.

Var. *β*, *oppressa*.—Tubes repent, branching or thickly intertwined, covering the substratum. Few or no vertical branches. Cuticula lightly colored to transparent.

Var. *γ*, *caespitosa*.—Tubes repent, with many elongated and branched vertical rami. Cuticula semiopaque, no evident keel.

\*Station E (main river) Illinois River, Havana, Illinois, September 10, 1894; \*Calumet River, South Chicago, August 10, 1881 (Forbes).

Var. *δ*, *fungosa*.—Tubes repent. Vertical branches close together, even fused, forming great solid masses. Cuticula brown; aperture hyaline, slightly elongated.

Pennisewassee Pond in Norway, Gorham, Great Falls, outlet of Great Pond on Cape Elizabeth, Presumpscot River, all in Maine; Fresh Pond, Cambridge, Mystic Pond, Arlington, Green River, all in Massachusetts (Hyatt); \*Payson Park, Belmont, Massachusetts, June, 1890 (C. B. D.), growing profusely on north side of stone wall; Lily Lake, Mississippi River bottoms near Quincy, Illinois (Garman, 1888).

#### PLUMATELLA PUNCTATA Hancock.

*Plumatella vesicularis* LEIDY, 1854.

*Plumatella vitrea* HYATT (1868).

Horizontal branches only. Cuticula delicate, colorless, hyaline. Elevated mouth cone, wrinkled and bespeckled with white. Found in Europe and North America.

Var. *α*, *prostrata*.—Stock repent and open, forming long hyaline tubes that give rise to only a few, likewise repent lateral tubes. (Plate V, fig. 7.)

Sebago Lake, Maine (Hyatt); Mystic and Fresh ponds near Cambridge (Hyatt, 1868); Schuylkill River, underside of flat stones (Leidy, 1854); Libby Lake, Mississippi River bottoms near Quincy, Illinois (H. Garman, 1888); \*East end Gibraltar, Put-in Bay, August 15, 1898; \*Long Point, Canada, August 21, 24, 1898.

Var. *β*, *densa*.—Stock repent, very thickly branched, completely covering the substratum, which seems enveloped in a thick layer of gelatinous vesicles.

#### LOPHOPUS Dumortier.

Colony shaped like a sack; erect, sometimes more or less lobed by indentations of margin, looking then something like a glove. Outer cuticula layer delicate and hyaline, more incrustated at base. Polypides scattered, a group of them rising from each lobe. Lophophors with about 60 tentacles. Statoblasts large, elliptical, but at each end drawn out into a sharp apex; float broad, hooks absent. The colony may divide along the constrictions between the lobes.



## LOPHOPUS CRISTALLINUS Pallas (1766).

This species possesses the characters of the genus.

*Habitat*.—Chiefly standing water such as pools or, rarely, slow-flowing streams. Chiefly attached to plant stems.

*Distribution*.—Europe; Schuylkill River near Philadelphia (Leidy, 1858); Illinois River at Havana (Kofoid, 1898).

## PECTINATELLA Leidy.

Colonies are hyaline and have the form of a rosette, lobed, with horizontal tubes only. They secrete a great gelatinous base which is common to many colonies. Aperture slightly elevated above common cœnecium. Statoblasts large and circular to subrectangular, with broad bent float and one marginal row of anchor-shaped hooks.

## PECTINATELLA MAGNIFICA Leidy (1851).

Polypides scattered or in double row along each lobe, the gelatinous base often 10 to 20 centimeters thick. Tentacles 60 to 84 in number. Statoblasts about 1 mm. in diameter, provided with 11 to 22 hooks from 0.15 to 0.25 mm. long. (Plate V, fig. 8.)

*Habitat*.—Submerged branches or twigs of trees, wooden stakes, gates of dams, walls of reservoirs, stones in brooks. Shady situations, such as south walls of reservoirs or wood-covered streams.

*Distribution*.—Confined to North America, except as introduced at Hamburg, Germany. \* Jones's Pond, near West Gouldsboro, Maine ("P. astræoidea, Hyatt," collected by Una A. Clark, 1897, in National Museum, Acc. No. 32589; also in Boston Soc. Nat. Hist.); Pennesseewassee Pond, Maine (20–22 hooks on statoblast); Fresh Pond, Cambridge, Massachusetts (12–17), both by Hyatt; \* walls of College Hill reservoir, Somerville, Massachusetts; \* Cold Spring Harbor, Long Island, New York, gates of dam between middle and lowest lake; Philadelphia (Leidy, 1851); Black Channel, Sandusky (Landaere, 1901); Jackson Park Lagoon, Lake Michigan, at Chicago (C. B. D., 1900); "back water" of Mississippi bottoms near Quincy, Illinois (H. Gorman, 1888); Columbus, Mississippi (Leidy, 1858); \* Squaw Bay, Put in Bay, Lake Erie (August 16, 1898, Reighard); \* Illinois River, near Havana, from rocks and shells, "island" near old bridge, October 14, 1894 (Forbes); \* Roadside Pond, in Hamilton County, Illinois (October 3, 1900, Forbes); \* Little Muddy River, Franklin County, Illinois, October 18, 1900 (Forbes).

## CRISTATELLA Cuvier.

Colony unbranched, gelatinous, with a flat "sole." External cuticula lacking, or developed merely as a thin gelatinous layer under the

sole. All polypides contract into a common cavity. Statoblast large, circular, with float and a circle of hooks on both sides.

*Habitat.*—In standing or slow-flowing water, on submerged branches of dead trees, underside of lily pads, and on other aquatic plants.

#### CRISTATELLA MUCEDO.

Young corm of circular form, later elongated, worm-like, attaining a length of 2 to 5 cm. in summer, to 28 cm. in autumn. Colonies often gregarious in a common gelatinous substance. Eighty to 90 tentacles. Statoblasts with 10 to 34 dorsal hooks, 20 to 50 ventral hooks. (Plate V, fig. 9.)

Var. *α*, *genuina* (= *C. ophidea* Hyatt, 1868).—Statoblasts less than 1 mm. in diameter; hooks on dorsal side 10 to 22; on ventral side 20 to 37.

*Distribution.*—Europe; Pennissewasee Pond, Maine (Hyatt, 1868); \* Fresh Pond, Falmouth, Massachusetts (C. B. D., 1889); \* Trinity Lake, Pound Ridge, New York (C. B. D., August, 1889); \* Union Lake, Illinois River, Havana, Illinois, May 12, 1894; \* Long Point, Canada (Reighard, August 21 and 24, 1899); Station E, Illinois River, Havana, Illinois, September 2, 1890.

Var. *β*, *ide* (= *C. ide* Leidy, 1858; *C. lacustris* Potts, 1884).—Statoblasts over 1 mm.; hooks on dorsal side 20–34; on ventral side 38–50.

*Distribution.*—Lily Pond, Newport, Rhode Island (Leidy, 1858; C. B. D., 1890); Harvey's Lake, Luzerne County, Pennsylvania (Potts, 1884).

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## EXPLANATION OF PLATE VI.

- Fig. 1. *Urnatella gracilis* from Illinois River at Urbana. x 20.
2. *Pottsiella erecta* from Kraepelin's figure of a Pennsylvania specimen. x 35.
3. *Paludicella ehrenbergii* from Illinois River. x 8.
4. *Fredericella regina* from East Harbor, Sandusky. x 10.
5. *Plumatella princeps*, var. *emarginata*, Squaw Bay, Put in Bay, Ohio; lily pads. x 6.
6. *Plumatella polymorpha*, var. *repens*, Lake Erie. x 8.
7. *Plumatella punctata*, var. *prostrata*, Lake Erie. x 8.
8. *Pectinatella magnifica*, on plant stem. Squaw Bay, Put in Bay, Ohio. x  $\frac{2}{3}$ .
9. *Cristatella mucedo*. Illinois River. x 10.